# FOOD-STORING BEHAVIOUR OF THE SOUTH ISLAND ROBIN

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ABSTRACT

A description is given of the food-storing behaviour of the South Island robin (Petroica australis australis). They stored whole or portions of invertebrate prey. Nearly 70% of cached items were earthworms. Most items were stored in sites close to where they were found, often branch-trunk axils.

Storing of food occurred throughout the year, but most frequently in autumn and winter. The mean time taken to store an item was 24 seconds. The mean height of store sites (2.85 m) was significantly higher than the mean height at which South Island robins gleaned from vegetation (1.49 m). They tended to store food most often in the morning and retrieved it mainly after mid-afternoon. Most items were retrieved within three days.

## INTRODUCTION

A variety of birds store food, especially birds of prey, shrikes and owls (Angel 1969, Collins 1976, Collopy 1977, Cope & Barber 1978, Dunn *et al.* 1976, Greaves 1968, Mueller 1974). Applegate (1977) saw a loggerhead shrike (*Lanius ludovicianus*) storing prey by impaling it on thorns, as did Durango (*in* Haftorn 1953) of red-backed shrike (*L. collurio*). Goodwin (1951) and Chettleburgh (1952) described nut burying by jays (*Garrulus glandarius*), and Purchas (1975) saw rooks (*Corvus frugilegus*) hiding nuts. Swanberg (1951) described nut hoarding by thick-billed nutcrackers (*Nucifraga caryocatactes*), and Haftorn (1953, 1956a,b,c, 1974) gave detailed accounts of storing of seeds and invertebrates by several *Parus* species. Food storing by South Island robins (*Petroica australis australis*) has been recorded by several observers (Falla *et al.* 1966, Flack pers. comm., Fleming 1950, Moncrieff 1932, Richdale 1941, Soper 1976), although not quantitatively. During a time-budget study of South Island robins at Kowhai Bush, they were often seen storing invertebrates.

In this paper a description is given of the food-storing behaviour of the South Island robin, the types of invertebrates

stored, the time taken to store an item, as well as the height and nature of the store site. The diurnal pattern of storing and retrieving food is described.

## STUDY AREA

All observations of South Island robins (henceforth referred to as robins) were made at Kowhai Bush, Kaikoura (42°S 174°E). Kowhai Bush is a 240 ha strip of forest on the north-eastern side of the Kowhai River. It is bounded by riverbed and farmland at 60-150 m a.s.l. The low forest consists of a flood-induced patchwork of successional stages of varying age, structure and species composition often dominated by kanuka (*Leptospermum ericoides*) with a dense understorey (Flack 1973). Kowhai Bush is described in detail by Hunt & Gill (1979). Observations were made between August 1976 to December 1978, when the population varied from 26 to about 110 individually colour-banded robins.

## METHODS

During studies of annual time-budgets, individual robins were watched about their territories. For the purpose of timing, food-storing behaviour started when a robin carrying food flew to a store site and finished when the bird departed after depositing the item. The time taken was recorded with a stop-watch to the nearest second. Food-storing behaviour was timed separately from other behaviour throughout the study, but from March to July 1977 and January to July 1978 data about the items stored, store sites and recovery of food were also recorded. Retrieval of stored food was seen infrequently and sometimes I was unsure whether cached or new prey was involved. Consequently, the retrieval of stored food was timed as foraging behaviour. Repeated visits were made to store sites to determine the time and day of food retrieval.

Robins were active throughout the daylight hours and in twilight. The limits of daylength were set at official sunrise and sunset, contained in The Air Almanac (USA Government Printing Office 1976). Each day was divided into six equal periods (Verner 1965), and each food storage and retrieval action was recorded as taking place within one of these periods. Those that took place in twilight before sunrise and after sunset were assigned to day-periods 1 and 6 respectively. Thus, it was possible to combine the data for storing and retrieval from different months even though daylength varied.

## FOOD-STORING BEHAVIOUR

Although robins ate invertebrates and berries, they were seen to store only the former. Prey were stored whole or in portions and singly at different sites. Prey too large to be carried in flight was broken up before storage. Before being cached, most prey were killed by mandibulation and slamming against a hard object more vigorously than when eaten immediately. However, on a few occasions prey, especially earthworms, were still writhing when stored so that some fell from the sites. Similarly, Haftorn (1953) found that crested tits (*Parus cristatus*) sometimes stored prey still capable of movement.

Robins were not very selective in choosing food storage sites as a variety of sites was used. Branch-trunck axils were the most frequently used sites but stump ends, holes and crevices were used also. Apparently ample sites were available since most items were stored within 10 m of where they were killed and broken up. Soper (1976) described robins storing food in "larders", as though such sites were repeatedly used. This was not found for robins in Kowhai Bush, sites were not used repeatedly. Also, a robin sometimes foraged beyond its territory during autumn and surplus food was not brought back into the territory to be put in larders, but was stored very near where it was found.

No effort was made to hide stored prey by covering it with bark or lichen, as did boreal chickadees (*Parus hudsonicus*) (Haftorn 1974). Stored items of robins were often visible from above. They were placed in sites and not forced in between two surfaces. Nor did it seem to be held in place by saliva produced by the bird (Haftorn 1953) or any similar method. Often stored prey adhered to the site because fluids that had issued from the prey's wounds had coagulated.

Male robins dominated their mates so that before a female cached food she often moved out of his sight. However, cases were seen where either sex immediately ate the stored food of their partner. Occasionally, instead of eating the stored food, they transferred it to a new site. This behaviour has also been observed in tits (Gibb 1960, Haftorn 1974) and rooks (Kallander, *in* Andersson & Krebs 1978).

Food storing was seen during most months of this study, but it occurred most frequently from April to July. Table 1 summarises the type and frequency of food stored each month. Nearly 70% of cached items were earthworms which were stored mainly during autumn and winter. Cicadas were the main food cached in summer. The mean height of store sites (n=293) was 2.85 m, with a range from 0.3 to 8.0 m. The mean height that prey were stored was significantly higher than the mean height at which robins foraged from vegetation (Table 2). Of 340 storing operations, the mean time taken was 24 seconds, varying from four seconds to two and a half minutes, although storage rarely took more than a minute. Of 40 stored items, 58% had disappeared, presumably retrieved, the same day they were stored.

TABLE 1. FREQUENCY OF FOOD TYPES STORED BY ROBINS IN THE NON-BREEDING SEASON (JANUARY-JULY)*, NYMPH.

| | 1977 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | A | M | J | J | J | F | M | A | M | J | J | Total | % |
| Total | 4 | 19 | 18 | 21 | 26 | | 7 | 10 | 20 | 43 | 59 | 42 | 269 | |
| Earthworm | 1 | 12 | 8 | 8 | 20 | | 1 | 7 | 17 | 36 | 45 | 33 | 188 | 69.8 |
| Slug | 1 | 2 | 1 | 3 | 2 | | | | 1 | 1 | 4 | 2 | 17 | 6.3 |
| Stick-insect | | | 2 | 2 | | | | | 1 | 4 | 3 | 2 | 14 | 5.2 |
| Cicada | 2 | | | | | | 6 | 2 | | | 1* | | 11 | 4.1 |
| Beetle larvae | | | 5 | 3 | 1 | | | | 1 | | | | 10 | 3.7 |
| Tree weta | | | | 1 | | | | | | | 4 | 2 | 7 | 2.6 |
| Ground weta | | 2 | 1 | 1 | 1 | | | | | | 2 | | 7 | 2.6 |
| Snail | | 1 | 1 | 1 | 1 | | | | | | | 1 | 5 | 1.9 |
| Caterpillar | | | | | 1 | | | 1 | | | | 2 | 4 | 1.5 |
| Flatworm | | | | 1 | | | | | | 2 | | | 3 | 1.1 |
| Spider | | 1 | | | | | | | | | | | 1 | 0.4 |
| Fly | | 1 | | | | | | | | | | | 1 | 0.4 |
| Cockroach | | | | | 1 | | | | | | | | 1 | 0.4 |

TABLE 2. A COMPARISON OF THE MEAN HEIGHT OF STORAGE SITES AND VEGETATION-FORAGING SITES.

| | Mean height (m) | Range (m) | S.D. | N |
|---|---|---|---|---|
| Storing site | 2.853 | 0.3-8.0 | 1.54 | 293 |
| Vegetation-foraging site | 1.485 | 0.1-8.0 | 1.15 | 500 |

(t=14.3514 for 792 d.f., P<0.05)

Fig. 1 shows the diurnal pattern of storing and retrieving food. Although both activities occurred throughout the day, robins tended to store food more often in the morning and retrieve it mainly after mid-afternoon.

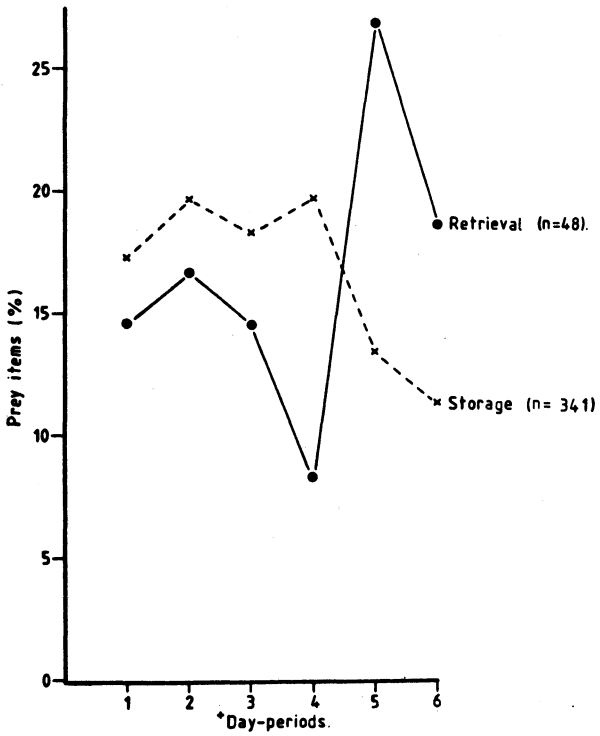


Fig. 1. Diurnal pattern of prey storage and retrieval by robins. *, daylight hours are divided into six day-periods of equal length.

## DISCUSSION

Food stored by robins consisted mainly of large prey that was broken up before being stored. Usually a robin ate a few portions of this prey and then cached the remainder. Earthworms were stored most often, which probably reflects their frequency in the diet during the non-breeding season. It is not known whether robins selectively stored particular prey species. Collopy (1977) found that the relative proportions of prey types cached correspond directly with the relative proportion captured by female American kestrels *Falco sparverius*.

Unidentified native earthworms were present in Kowhai Bush and were occasionally captured by robins. Many were 10 mm in diameter with an average length of about 200 mm. Such large prey were never eaten completely, possibly because the bird's

proventriculus was not capable of holding so much food, and the excess was stored. Thus, for the robin, cached food seemed to be surplus to their immediate requirements. As the non-breeding season progressed robins spent more time storing food, even though they spent fewer hours per day foraging (Powlesland in prep.). I presume that robins foraged less per day in June and July (winter) than previously because of the shorter daylengths and not because food was more abundant. Therefore, as well as storing surplus food, it seems that robins stored at least some food as a source of food for use when prey found by hunting did not meet their maintenance requirements. It is also possible that prey, particularly earthworms, were more available in winter.

Haftorn (1956c) found that the willow tits' (*Parus atricapillus*) storing sites corresponded to their feeding areas, but that boreal chickadees stored food at levels lower than where they foraged (Haftorn 1974). The mean height of robin storage sites was higher than their mean foraging height, but within the height range that they fed. Suitable storage sites are probably infrequent higher in the canopy and this possibly limits the height of food storage. Also, the more open nature of the canopy may make sites at these heights more susceptible to potential cache robbers, such as brown creepers (*Finschia novaeseelandiae*), bellbirds (*Anthornis melanura*) and *Turdus* species. Robins showed a high degree of interspecific territoriality (Flack, 1976), especially around their caches, but I never saw other species taking their stored food. However it is likely that other birds, rodents and mustelids do find and take stored food.

Crested tits usually took 30 to 50 s to find, kill and store an item (Haftorn 1953) and boreal chickadees took about 40 s (Haftorn 1974) to collect and store insect larvae. Although collection times of items were not recorded for the robin, the mean storage time of 24 s suggests that the time taken to find, kill and store items is similar to that for other species. By comparison, tits spent a long time looking for places in which to store their food and investigated many trial places before choosing one that was suitable (Gibb 1960). Thus, tits appear to spend longer in this activity than robins because the latter usually stored their prey in the first site visited.

Storage of food by robins was a short-term process lasting only a few days at most, compared with several months for rooks (Purchas 1975) and tits (Haftorn 1956c). Hoarding of invertebrates by tits in England (Gibb 1960) and Norway (Haftorn 1953) for retrieval in winter was presumably feasible because the food would have been preserved by natural freezing in the colder climate. At Kowhai Bush stored items quickly decomposed even in winter. Several items seen in cache sites after four days may have been rejected because of their state of decay. However, dried earthworms were occasionally retrieved and eaten so that some food was acceptable after several days.

Robins tended to store and retrieve prey throughout the day, but with less storing and more retrieving late in the day. Crested tits (Haftorn 1953), thick-billed nutcrackers (Swanberg 1951) and jays (Chettleburgh 1952) all displayed a diurnal

pattern of food storage with the intensity rising in the morning, reaching a peak about midday, and declining afterwards. Collopy (1977) found that female American kestrels tended to store prey throughout the day, but retrieved it in the late afternoon. He concluded that such behaviour "may dampen daily variation in food availability for the diurnal-hunting kestrel".

After storing food robins usually began hunting again unless an unusually large prey was caught, partially eaten and the rest stored. In this case storing was followed by preening and resting. However, normally they continued to hunt and store more prey. By hunting throughout the day robins could increase their food consumption by storing prey whenever an excess was captured. Late in the day they had to capture enough prey to meet their immediate physiological requirements as well as to sustain them through the night. Consequently, they tended to consume more of the prey captured in the late afternoon and recovered stored prey as well. Also, some prey stored the previous day was available in the early morning to provide a quick source of food after the long night fast at a time when invertebrates were likely to be least active and therefore more difficult to detect.

Collopy (1977) estimated that female American kestrels rediscovered 70% of stored prey. Chettleburgh (1952) and Goodwin (1951) found that jays could relocate stored food several months after hiding it. Swanberg (1951) noted that the thick-billed nutcracker also had "a fantastic power of rediscovering its stores" several months later, even when covered by thick snow. Haftorn (1953, 1974) concluded that tits and chickadees, which stored collectively and therefore found and ate one anothers' stores, did not remember the exact location of each store site, but recovered caches on the basis of a general recall of storing locations with some trial and error search at likely sites. Robins found their stored food readily. On one occasion the male of an incubating female collected food from five different sites in succession before taking all of it to her.

Many species depend on their ability to relocate stored food for survival and reproduction. Thick-billed nutcrackers (Swanberg 1951) and Clark's nutcrackers (*Nucifraga columbiana* (Bock *et al*. 1973) both stored hazelnuts for consumption during winter and spring and for feeding to their young. Haftorn (1956c) showed that a willow tit population in Norway relied to a very great extent on stored food in winter. In Norwegian spruce forest, Haftorn (1954) concluded that up to about 60% of the mid-winter food of crested tits consisted of stored seeds. Similarly, Purchas (1975) found that rooks spent 30 to 50% of autumn and winter feeding time locating, eating and transferring nuts to new locations. He showed that when hidden nuts were sought, individuals returned to their favoured feeding areas and recovered them.

There are several reasons why storing food was advantageous to robins. By not having a crop the amount of food they can ingest at a time is limited. Hoarding any surplus enabled them to eat it later, saving energy and time by not having to search

for prey when less readily available. Because of their highly territorial nature against conspecifics, except their mates, the chances of other robins pirating their caches were low. By hunting again after storing, robins may take advantage of temporary prey abundances for consumption when prey is scarce. Small birds, such as robins, have a high metabolic requirement which takes about 90% of the day in winter to satisfy (Powlesland in prep.). Therefore, during periods of adverse weather stored food could aid survival.

Although caching was not seen frequently during the breeding season because males fed most surplus prey to their mates and young, males were observed gathering stored food to feed their mates, especially during the first nesting cycle. At that time of year (August-September) long nights, cool temperatures and frequent inclement weather may sometimes prevent males maintaining a steady supply of food to the female, which she relied on for maximum attentiveness to the eggs and young nestlings. The proportion of eggs and nestlings abandoned was much higher early in the breeding season that afterwards. Presumably, nesting success would have been lower still early in the season if males had not taken advantage of temporary abundances of prey and used these sources to feed their mates when prey was less readily available. Applegate (1977) found this situation in the loggerhead shrike where the female relied on her mate's hoarded food to maintain the degree of attentiveness necessary for successful incubation and brooding. Robins were the first passerines to start breeding each year in Kowhai Bush and this may have been partly because of the advantages conferred by storing food.

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## LITERATURE CITED

ANDERSSON, M. & KREBS, J. 1978. On the evolution of hoarding behaviour. *Animal Behaviour 26:* 707-711.

ANGEL, T. 1969. A study of the ferruginous hawk: adult and brood behaviour. *Living Bird 8:* 225-241.

APPLEGATE, R.D. 1977. Possible ecological role of food caches of loggerhead shrike. *Auk 94:* 391-392..

BOCK, W.J., BALDA, R.P. & VANDER WALL, S.B. 1973. Morphology of the sublingual pouch and tongue musculature in clark's nutcracker. *Auk 90:* 491-519.

CHETTLEBURGH, M.R. 1952. Observations on the collection and burial of acorns by jays in Hainault Forest. *British Birds 45:* 359-364.

COLLINS, C.T. 1976. Food-caching behaviour in owls. *Raptor Research 10:* 74-76.

COLLOPY, M.W. 1977. Food caching by female American kestrels in winter. *Condor 79:* 63-68.

COPE, J.B. & BARBER, J.C. 1978. Caching behaviour of screech owls in Indiana. *Wilson Bulletin 90:* 450.

DUNN, G.L., KLEM, D., KIMMEL, T. & MERRIMAN, T. 1976. Surplus killing and caching by American kestrels (*Falco sparverus*). *Animal Behaviour 24:* 759-763.

FALLA, R.A., SIBSON, R.B. & TURBOTT, E.G. 1966. *A Field Guide to the Birds of New Zealand and Outlying Islands*. Collins, London. 254 pp.

FLACK, J.A.D. 1973. Robin research - A progress report. *Wildlife - A review 4:* 28-36.

FLACK, J.A.D. 1976. The use of frontal spot and crown feathers in inter- and intraspecific display by the South Island robin, (*Petroica australis australis*). *Notornis 23:* 90-105.

FLEMING, C.A. 1950. New Zealand flycatchers of the genus *Petroica* Swainson (Aves). Part 2. *Transactions and Proceedings of the Royal Society of New Zealand 78:* 127-160.

GIBB, J. 1960. Populations of tits and goldcrests and their food supply in pine plantations. *Ibis 102:* 163-208.

GOODWIN, D. 1951. Some aspects of the behaviour of the jay (*Garrulus glandarius*). *Ibis 93:* 414-442 and 602-625.

GREAVES, J.W. 1968. Food concealment by merlins. *British Birds 61:* 310-311.

HAFTORN, S. 1953. Contribution to the food biology of tits especially about storing of surplus food. Part 1. The crested tit (*Parus cristatus* L.). *Det Kgl. Norske Videnskabers Selskabs Skrifter 4:* 1-122.

HAFTORN, S. 1956a. Contribution to the food biology of tits especially about storing of surplus food. Part 2. The coal-tit (*Parus ater* L.). *Det Kgl. Norske Videnskabers Selskabs Skrifter 2:* 1-52.

HAFTORN, S. 1956b. Contribution to the food biology of tits especially about storing of surplus food. Part 3. The willow-tit (*Parus atricapillus* L.). *Det Kgl. Norske Videnskabers Selskabs Skrifter 3:* 1-79.

HAFTORN, S. 1956c. Contribution to the food biology of tits especially about storing of surplus food. Part 4. A comparative analysis of *Parus atricapillus* L., *P. cristatus* L. *and P. ater* L. *Det Kgl. Norske Videnskabers Selskabs Skrifter 4:* 1-54.

HAFTORN, S. 1974. Storage of surplus food by the boreal chickadee *Parus hudsonicus* in Alaska, with some records on the mountain chickadee *Parus gambeli* in Colorado. *Ornis Scandinavica 5:* 145-161.

HUNT, D.M. & GILL, B.J. (Eds.) 1979. Ecology of Kowhai Bush, Kaikoura. *Mauri Ora Special Publication 2.* 54 pp.

MONCRIEFF, P. 1932. Notes on the South Island robin. *Emu 32:* 52-58.

MUELLER, H.C. 1974. Food caching behaviour in the American kestrel (*Falco sparverius*). *Zeitschrift fur Tierpsychologie 34:* 105-114.

POWLESLAND, R.G. in preparation. A time-budget study of the South Island robin (*Petroica a. australis*) at Kowhai Bush, Kaikoura. Ph.D. thesis, University of Canterbury, Christchurch, New Zealand.

PURCHAS, T.P.G. 1975. Rooks (*Corvus frugilegus frugilegus* L.) hiding nuts in Hawke's Bay. *Proceedings of the New Zealand Ecological Society 22:* 111-112.

RICHDALE, L.E. 1941. *Notes on the Southern Robin (Miro australis).* Otago Daily Times and Witness Newspaper Co. Ltd. Dunedin. 8 pp.

SOPER, M.F. 1976. *New Zealand Birds.* Whitcoulls, Christchurch. 251 pp.

SWANBERG, P.O. 1951. Food storage, territory and song in the thick-billed nutcracker. Pp. 545-554. *In* Hörstadius, S. (Ed.). *Proceedings of the 10th International Ornithological Congress.* Almqvist and Wiksell, Uppsala. 662 pp.

VERNER, J. 1965. Time budget of the male long-billed marsh wren during the breeding season. *Condor 67:* 125-139.